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EDITORS' OUTLOOK

As we look ahead to the coming school year, we are deeply concerned as to how THIS JOURNAL can be of the greatest value to the teachers of Chemistry. The suggestions which seem to stand out as the most promising are the three following:

1. Each issue of THIS JOURNAL to contain abstracts of articles on chemical education found in other Journals.
2. To run a series of articles on the Application of Educational Psychology to the Teaching of Chemistry.
3. To make THIS JOURNAL an International Journal of Chemical Education.

Suggestions (1) and (2) were given in the June issue and sufficient favorable comment has been received to warrant their adoption as soon as an organization can be completed for their proper execution. Suggestion (3) calls for more careful consideration. There seem to be advantages and also disadvantages in such a project.

There are definite indications that an international journal is desired. This has not only been voiced by teachers of this country, but we have had two such requests from foreign countries. THIS JOURNAL already has subscriptions in five different nations, and therefore in a sense might be considered international. On the other hand, no publication can be considered as truly international until, at least, it contains articles whose authors are from these countries. Foreign contributions have already been offered. Chemistry teachers of this country would be much benefited by reading about the chemical educational movements in other countries, and vice versa.

An international journal should not be a chemical lesson quarterly,

a teachers' monthly exposition, nor a monthly given to research in the pure science of chemistry, but it should have the spirit of research, where such spirit hovers around research in pure chemical education. Chemistry is fast becoming one of the greatest sciences on the face of the globe. An international journal would do much to help teachers keep in touch with its progress. It should be so constituted that it would function in the high schools, colleges, universities and industries. It should not only give the most progressive aims, principles and methods in the field of chemical education in the various countries, but it should also set forth in its pages the advancements in chemical psychology, vital teaching, better chemical educational organization, and administration. Such a journal would help systematize our chemical teaching, crystallize our best methods, and organize new methods as our ever advancing science demands. In a word the teaching of chemistry would become a science.

The advantages of an international journal seem to thrill us with hope, yet we should pause to see if there are any dangers. An international journal would have to be very cautious to be fair to its complex constituency, boosting chemical educational progress and not denominational organizations, plans and personnel. It would have to constantly strive to retain the standards of a high grade journal, yet it must live where the teachers live, and lead them up to a point where chemistry is one of our best taught subjects. The JOURNAL must constantly keep in mind the professionally trained in Chemical Education, and at the same time those who have not "yet attained," but are climbing toward the coveted heights with great eagerness. A true leadership in journalism starts where it finds people and constantly strives to lead them to higher levels. Readers of the JOURNAL would have to pass through a period of patience while this coöperative international experiment was being brought to a degree of perfection.

An international journal would be a real experiment in chemical education. Is it worth while, and do you want it?

N. E. G.

TESTS OF ACHIEVEMENT IN CHEMISTRY*

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An extensive testing program has been carried out for the purpose of measuring the ability of high school children to do, after instruction, a large number of specific tasks in chemistry. Tests were given on each of four years and in each case to high school students who had studied chemistry for one year. In all, 350 distinct tasks were arranged in tests and administered to large numbers of students. This paper reports briefly the method of constructing the Test for General Chemistry[1] from the mass of experimental material used and it gives some evaluation of its usefulness in educational work.[2]

The Test for General Chemistry is published in two forms designated as Form A and Form B. These are of the same types of items and they are of equal difficulty. Scores on one form of the test are directly comparable with scores on the other form. The time allowed for administering either form is 35 minutes.

Each form consists of two parts. Part I is a test range of information about chemistry. It is composed of 30 items. These test a wide range of knowledge including biography, chemical properties, chemical composition, commercial processes, and terminology. Part II consists of 37 items and tests the students' ability to write formulas and equations, to give the chemical name of common substances, to give chemical composition, and to do simple calculations.

The tests should prove of value to teachers of chemistry in several ways:

1. In the assignment of school marks, in furnishing a more objective and reliable basis than that afforded by the judgment of the teacher alone.
2. In the determination of promotions and failures.
3. In comparison of the results obtained by the teacher of one class with those of another teacher in the same school or in different schools.
4. Students who do well in this test may be expected to do well in college entrance examinations and in more advanced courses in chemistry.
5. Limited data with these tests suggests their usefulness with entering college students for purposes of classification. The data point to the conclusion that students who have had high school chemistry but who do very poorly on the test should not be expected to make rapid progress in college chemistry.

* Read before the Division of Chemical Education at Washington Meeting of the A. C. S., April 24, 1924.

[1] Published by World Book Co., Yonkers, New York, 1924.

[2] A more detailed analysis of the test results is presented elsewhere.

S. R. Powers, "A Diagnostic Study of the Subject Matter of High School Chemistry." Teachers College, Columbia University, Contributions to Education, No. 149, 1924.

Each form of the test consists of 67 items. The 134 items of the two forms were selected from the total of 350 which were used in experimental forms. Items were selected which were common to high school textbooks in chemistry and which chemistry teachers were emphasizing in their courses. Great care was taken to select items the scoring of which could be done entirely objectively.

The test items are arranged in order of difficulty. The range is from very easy to comparatively difficult items. The easiest item was answered correctly by 88 per cent of the experimental group. The most difficult item was answered correctly by 12 per cent. The average difference in difficulty between successive items is one-tenth of the difference between the difficulty of an item answered correctly by 50 per cent and one answered correctly by 75 per cent of the experimental group. The range of difficulty of Part I of the test is nearly the same as that of Part II. The first item of Part I and the first item of Part II were done correctly by nearly the same number of students.

The difficulty of each of the 350 items of the experimental forms was determined by computing the percentage of a large number of students who were able to do them correctly. The smallest number of students counted in computing the difficulty of an item was 418. For many of the items the number was more than 1000. More than 50 high schools have coöperated in this work.

Standards of achievement by high school students may be illustrated by test items selected at different levels of difficulty. Illustrative of those answered correctly by approximately 75 per cent are:

Acetic acid is contained in vinegar.

Charcoal is essentially carbon.

Sodium bicarbonate is manufactured by the Solvay process.

Hydrogen fluoride is used for etching glass.

The ratio in grams between hydrogen, sulfur and oxygen in H_2SO_4 is 2 : 32 : 64.

Write the name of $(NH_4)_2SO_4$.

Write the formulas of hydrogen sulfide, sodium sulfate, and silver chloride.

Complete the equation $NaCl + Pb(NO_3)_2 \longrightarrow ?$

Write the equation for the preparation of hydrogen chloride from sulfuric acid and salt.

Illustrative of those done correctly by approximately 25 per cent are:

Nearly all fuel substances contain carbon and hydrogen.

Silver coin is an alloy of copper and silver.

The Haber process is used for the manufacture of ammonia.

Wool is bleached with sulfur dioxide.

Write the name for $KClO_2$.

Write the formula for silver sulfide.

Complete the equation $H_2S + HClO \longrightarrow$?

Write the equation for the action of sulfuric acid on sodium sulfite.

These were done correctly by but 10 per cent:

Compute from percentage composition of two oxides of nitrogen the ratio between variable amounts of oxygen which combine with a fixed amount of nitrogen.

Write the formula of arsenious sulfide.

Complete the equation $Cu + H_2SO_4$ (hot conc.)$\longrightarrow$?

Write the equation for the decomposition of ammonium nitrate by heat.

Thirty-six of the 67 items selected for each form of the Test for General Chemistry were answered correctly by 50 per cent or more of the students to whom the experimental forms were given.

The reliability of the tests was computed by correlating the scores of students on similar forms. The average of six coefficients of correlation between forms like Form A and Form B of Tests for General Chemistry is 0.796 ± 0.02. The experimental tests were of 30 items each and each required less than 20 minutes for administration. The reliability of the scores on both Part I and Part II of the test is approximately the same.

The probable error of a score is a function of the correlation coefficient. It is obtained by formula $\text{P.E.}_{(\text{score})} = 0.6745\sqrt{1 - r_{(\text{reliability})}}\,\sigma_{(\text{dist. of scores})}$ in which sigma is the measure of deviation of scores and r is the coefficient of correlation. The sigma of the entire test is approximately 9 points of score. If 0.80 is accepted as the value of r, $\text{P.E.}_{(\text{score})}$ of Tests for General Chemistry become approximately 3. This value indicates that the true score of the student on the test will not vary from the obtained score by more than 3 points.

A measure of the usefulness of the tests is obtained from a comparison of test scores and teachers marks which have been assigned independently of the tests. Such a comparison furnishes an indication of the relationship between the ability measured by the test and that rewarded by teachers in assigning marks. The well known unreliability of school marks places a limitation upon the significance which may be attached to such comparison. The reliability of the marks of the different teachers, has not been determined as it has for the tests. The tests are objective measures of achievement. Marks are influenced by subjective judgment and may measure in addition to achievement, docility, possibly good looks, teachers' idiosyncrasies, and other things. It is therefore impossible to indicate to what extent the lack of relationship between test scores and teachers' marks is due to unreliability of the marks as measures of achievement and to what extent it is due to the fact that marks are an evaluation of attributes which the tests do not measure. Correlations between scores on different forms of the tests and marks of different teachers range from

0.54 ± 0.11 to 0.78 ± 0.04. The average of seven coefficients is 0.66. Each of these is large enough to indicate a definite relationship. The scatter-charts shown as Table I and Table II indicate more concretely the meaning of the coefficients. These show the distribution of marks assigned independently of the tests to students whose scores were at different levels on one form of the experimental tests. The test scores are in terms of the number of tasks done correctly. The entire test consists of 30 tasks. The range of each score level includes about 25 per cent of the scores made in the given school. Table I is read: of 18 students in School A who answered 18 or more of the test items correctly 5 received the highest mark, 12 received either the highest or next to the highest mark and none failed. At the other extreme 2 of those who did less than 12 items correctly failed and 10 received the lowest passing mark. Similarly for Table II, all of those in the best 25 per cent on the test received either the highest or next to the highest mark; those of the lowest 25 per cent received in general the lowest marks. This test may be administered in less than 20 minutes. Its usefulness for purposes of rating students seems to be established.

TABLE I—SCHOOL MARKS AND TEST SCORES, SCHOOL A

	Teachers' marks					
Test scores	A	B	C	D	Fail	Total marks
18 and above	5	7	5	1	0	18
15–17	1	6	4	4	2	17
12–14	0	7	5	7	1	20
Less than 12	1	3	1	10	2	17

TABLE II—SCHOOL MARKS AND TEST SCORES, SCHOOL B

	Teachers' marks					
Test scores	A	B	C	D	Fail	Total marks
25 and above	6	3	0	0	0	9
22–24	2	3	3	0	0	8
20–21	0	3	3	3	0	9
Less than 20	0	3	7	1	2	13

Another interest in these tables is in the difference which is shown to exist between the standards of achievement in the two schools. This would seem to be of particular interest to those in charge of beginning classes in college chemistry. Without the test scores a mark of A in School A might be interpreted to mean the same as a mark of A in School B. Note, however, that the scores on the test of the best 25 per cent of those in School A is actually lower than the scores of the poorest 25 per cent in School B. Approximately 75 per cent of the students in School B score more than 19 points on the test. Approximately 75 per cent of those in School A score less than 18 points on the test. Unquestionably the standards of achievement by students in School B is much above that of School A. Yet traditional practices afford no means of recognizing this difference.

The unfairness of practices which evaluate the standards of work in School B as equal to that of School A is manifest. College teachers are prone to issue tirades concerning the ignorance of beginning college students who have studied chemistry in high school. The justice of this in any case is questionable but the injustice is unquestioned when criticisms made as a result of contacts with students from School A are applied equally to those from School B. In fairness to the teacher as well as to the student some provision should be made by means of which recognition may be given for superior achievement in high schools. There is evidence to show that the quality of work done in some high schools is on a level with if not superior to that done in some of the colleges.

Limited use of the tests suggests that they may be useful instruments for differentiating college students on the basis of ability to do successful work in chemistry. The possibilities have not been explored at all exhaustively. At the opening of the fall session of the University of Minnesota, 1921, tests were given to 360 entering students who had studied chemistry in high school and who had elected to take additional chemistry in the University. It has been the practice at the University of Minnesota for a number of years to group together for instructional purposes those who had taken chemistry in high school. Of the 360 tested 142 had taken chemistry during the year immediately preceding entrance to the University. A comparison of the test scores made at the opening of school with the average of the marks assigned these 142 students at the end of the first and second quarter shows rather marked agreement. The scatter-chart shown as Table III indicates this relationship.

The marks assigned were reduced to numerical values which may be termed grade scores by weighting A equal to 4, B equal to 3, C equal to 2, D equal to 1, and F as 0. The grade scores of Table III were obtained by adding weighted values of the marks made by the students during each of the two quarters. A score of 8 corresponds to two A's, that is, A as a reward for the work of each quarter, a score of 5 to a C and a B, etc. The table indicates the grades received by students whose score on the test fell within each quartile of the distribution of the scores of 142 students. The grades of 30 of the 38 students whose test scores were 16 or higher were C or better. The grade of 29 of the 39 students whose test scores were in the first (lowest) quartile (score less than 9) was D or F.

TABLE III—RELATION OF SCALE SCORES AND GRADES

Test scores	Grade scores 6, 7, 8	4, 5	2, 3	0, 1	Total marks
16 and above	15	15	7	1	38
12–15	8	12	3	3	31
9–12	4	7	14	9	34
Less than 9	4	6	12	17	39

Table III suggests a partial solution to the problem of giving proper recognition for high school work. The quality of college work done by 29 of the 39 students in the lowest quartile must be rated as unsatisfactory. It is appropriate to inquire as to what injustice would have been done if immediately following the administration of the tests the instructor in charge had assigned to a slow moving section all of the 39 in the lowest one-fourth of the group. Twenty-nine students would certainly have benefited by such administrative action; possibly four would have been treated unfairly. The remaining 6 whose work was rated as C (average) might be equally well placed in either the rapid or slow moving section. The tests used were very brief, less than 20 minutes being required to administer them. The data available suggest that the use of more comprehensive tests will afford a satisfactory basis for selection from those who have had chemistry in high school, the ones who are able to take chemistry in the University in rapid moving sections. Tests may afford a basis for recognizing, according to an intelligent principle, of work done in high school that which is and that which is not worthy of recognition.

This problem is an important one, for grave injustices are done to large numbers of students on account of failure to recognize the value of instruction which students have received in high school. Would it be appropriate to suggest that the members of the Section of Chemical Education direct their efforts toward the serious study of this problem in all of its relationships?

The administration and use of the tests like those for General Chemistry involves no difficulties. The time allowance of 35 minutes is sufficiently liberal to allow most students to finish. Extension of the time will not appreciably affect the scores. Scoring is done entirely by means of a key. The subjective judgment of the scorer does not enter into the determination of a score. A student's score on the test indicates simply the number of responses to the items of the test which he made correctly. The range of the test is such that very few students will be able to complete it; yet there are items simple enough to test even very poor students. While standard tests have evident limitations their usefulness to the teacher as instruments for evaluating and improving his work is established.

Abstracts of Ithaca Meeting

The abstracts of the papers given before the Division of Chemical Education of the A. C. S. at the Ithaca Meeting were received too late for THIS JOURNAL. They will be published in the October issue.

SHOULD THE ELECTRON THEORY BE INCLUDED IN HIGH SCHOOL CHEMISTRY?*

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Teachers of Chemistry in secondary education must soon, if not at present, give serious thought concerning what attitude they shall take in presenting certain phases of the Electron Theory to their chemistry classes. So much has been accomplished in the past few years to establish beyond question certain aspects of the subatomic structure of matter; so much is being printed and set before the reading public of work done and facts brought out about the conception of the atom that the teacher cannot disregard it for it is in our very midst. Can we use it? Can we harmonize any part of the idea into our present theoretical topics and assumptions as studied in first year chemistry?

A questionnaire was sent to chemistry teachers in all the public high schools in New England where the population in the community exceeded ten thousand, and also to recognized private schools. In addition some fifty high schools in our largest cities in the country were canvassed, making a total in all of about three hundred teachers who were solicited for their opinions. Approximately 75 per cent of the queries were returned for tabulation with 85 per cent of the questionnaire completed in each case. No claim is made that the canvass was broad enough to establish without further question the necessity of adopting into our secondary school chemistry the Electron Theory as it now exists, but it is felt that the results already obtained are fairly representative of the consideration that this Theory is being given by teachers in our high schools.

The question was asked if any phase of the Electron Theory should be given in high school chemistry and 74 per cent of the replies were in the affirmative. This tallies very noticeably with the 73 per cent of instructors who reported that they were teaching parts of the Electronic Theory to their chemistry classes. A small number of instructors are giving assistance to pupils interested in the subject and are carrying on forum meetings among selected groups for the purpose of investigating the new atom. However, since this latter group is discriminating in instruction, it is not included in the 73 per cent of teachers who are explaining portions of the Theory to their classes. And there is, too, a prevailing feeling among many teachers that the student should not be left in ignorance of the modern conceptions of matter, since increasing interest is apparent among the youth who are demanding of the teacher some explanations of the difficulties they experience as they read about electrons. And why should not the teacher of science be the child's objective in this matter and why should not the teacher meet the demands if logical?

* Read in the Division of Chemical Education of the American Chemical Society at the Washington Meeting, April 24, 1924.

Teachers do not hesitate to teach pupils to read long before they require a knowledge of the parts of speech, or a satisfactory concept of the facts contained therein.

The question must naturally arise as to where the Electron Theory might best be presented in the chemistry course. If 73 per cent of the teachers canvassed are using it in the development of the year's work, certain it is that it should not be thrown in when there is nothing else to employ or when interest lags. Interesting though the subject may be, it must serve a more fundamental use in our science else it would be foolhardy to advocate its adoption and it should be relegated to phantasy. Many reports approved of introducing the Theory early and continuing applications of it throughout the course as time and needs permit, and the investigation showed that 65 per cent of the teachers believed that the Electronic structure of matter could well be studied under the topic of atoms and molecules. The atom of Dalton has been considered, up to the present, a simple and satisfactory explanation of a simple unit of matter. No student can gain a true understanding of chemistry until he can think in terms of atoms and molecules, and can so express himself and interpret these concepts in chemical equations. This atom, however, should be modified by a simpler unit to include the atom of Lewis, Bohr and others.

Would it be advisable to discontinue any discussion of it until the Periodic Classification of the elements is reached? Fifty-one per cent of the replies received favored beginning the subject here. It is likely, however, that were a census of opinion taken among chemistry teachers relative to the value and importance of the periodic arrangement in a first year course, that various contradictory views would be advanced. It is not surprising then, that to study the periodic arrangement of the elements as modified by the present ideas of atomic structure, would cause, likewise, conflicting tendencies. This much then, cannot be considered conclusive.

If this Theory is to be given to students in any form and at various intervals, how can it best be assimilated by them? Five questions were asked, which, though they do not pretend to cover all methods that might be used, are, nevertheless, common methods of instruction. First, teachers were asked to report if assignments on the Theory should be given to students for home preparation; second if the Theory should be in the form of lectures to the students; third, if reading assignments should be demanded followed by a written report; fourth, if recitations and examinations should be required; fifth, if lectures and reports should be correlated. Sixty-nine per cent of the teachers reporting were opposed to any such plan as giving assignments to pupils for a home preparation of the Electron Theory, while but fifty per cent of the teachers in the schools outside of the New England states were opposed to the method. It was almost

unanimously agreed that lectures to students were a satisfactory method—86 per cent being in favor of this procedure. Fully 73 per cent were opposed to the plan of requiring recitations and examinations on the Theory though the schools outside of the New England States were about equally divided on this plan. Only 34 per cent of the replies favorably considered outside reading assignments and reports made on the subject matter covered, as a satisfactory method of teaching the Theory. This third question in some respects is closely akin to the first and in like manner the opposition was similar. The last question, that of correlating lectures and reports met the approval of 85 per cent of the teachers. This tallies well with the second. Naturally lectures must precede reports, but reports should be required as necessary adjuncts to lectures whereby a conception of what the student has gained may be shown. It must be conceded that if teachers are to give to students the Electronic form of matter, that it must be done through lectures mainly, for no textbooks contain a presentation of this Theory in an elementary form of sufficient worth to make it stand upon its own feet. Of twenty recent elementary chemistry texts examined, seven do not mention electrons at all; two barely mention them; four devote about one-half a page to the subject; and one devotes about a page and a half to it. Sufficient argument some would say to prove that the subject does not belong in our high school chemistry.

But note. Teachers are recommending to interested students and to their classes, such books as Mill's "Within the Atom," "The Letters of a Radio Engineer to his Son," and "The Reality of Modern Science;" Soddy's "Matter and Energy;" Langmuir's "The Arrangement of Electrons in Atoms and Molecules;" Comstock and Troland's "The Nature of Matter and Energy;" and Millikin's "The Electron." What teacher has not received from the hands of some young investigator earnestly seeking for information and enlightenment, clippings from papers and magazines about this new science of matter? These cannot be turned away and the number of inquiring minds will become legion ere long if the public press continues to devote space to reports of scientific meetings, digests of scientific lectures and articles from current magazines. These are the clearing houses of thought which the young intellect sees, reads, ponders and cogitates over. The public and school libraries contain all these facts, which are being drawn upon continually and more abundantly by the youth of our era.

It is quite certain from reports tabulated that the majority of teachers feel incompetent to teach the Electron Theory or any part of it—for when the question was asked if they believed that instructors could, with any degree of success, deal with the subject, at least three-fourths of the replies were in the negative. And there are several good reasons no doubt for this adversity. First, teachers of science have not until recently con-

sidered these new phases of atomic structure of sufficient value to warrant an investigation; second, the great majority of science teachers received no college training in the subject of electrons; third, up to recent date but little information has been available of adequate clarity to be instructive enough to serve as a teaching basis for the new atom.

But teachers cannot hide behind such excuses for long. The new science of matter may change ere long and be out of fashion, but this new hypothesis is ever being crowded into our present existence and teachers competently or incompetently, should make it their business to find out something about this new thought, which afterward can be confirmed or denied as the case may be. Then too, so long as teaching is a profession it will have before it the contact of youth struggling with the facts of modern thought. Should science be explained away with a gesture? Chemistry is not as important as Matter.

Upon many occasions the statement has been made that our scientific courses in the secondary schools are formulated and built up by what the colleges require and hence that, unless colleges insist that entering students know something about the Electronic Hypothesis of Matter, the high school teacher should consider it no concern of his. Ninety per cent of the teachers canvassed reported, that to the best of their knowledge, colleges with which they were familiar, do not require of high school students a conception of the Electron Theory. Nevertheless these same teachers are realizing that there is a growing tendency among college instructors to expect that, when the term "electron" is mentioned in their classes, the ex-high school student will be able to associate with the word some simple connective ideas. Naturally practice varies in various colleges. Some central and western colleges and several colleges in New England according to the report, do not require their entering pupils to give details of the new atom, but they do expect that these same pupils have brought with them something beyond the atom of Dalton and are not ignorant of the modern trend of thought.

There is too much diversity of opinion existant between teachers in secondary schools and in colleges to argue here the wisdom of requiring the Theory for entrance to college. Some college instructors feel that the student in high school may gather false notions of the electron which would take time to correct and hence the subject should be left to them to develop. Other college instructors take a broader viewpoint and state that it is not wise for colleges to demand of high school students a knowledge of the Theory, since on the whole, high school instructors have had little opportunity to know much about it, and that too, the usual numerous and diversified tasks of the high school teacher make this new demand an additional load. A majority of secondary school teachers are quite in accord with these views in that 82 per cent of them reported in the ques-

tionnaire that it would be unwise for colleges to demand that students retain more than a few simple ideas of the Theory. Teachers as a whole do not challenge the right of college instructors to expect pupils to understand that atoms are divisible and that matter is perhaps electronic, so long as they hold uppermost the realization that the minds before them are of a younger generation than theirs. This would mean, then, but an elementary knowledge of the new principles.

However, when teachers were asked if the subject should be treated by colleges solely, opinion was about equally divided among them for 47 per cent considered it a subject for the colleges alone, and 51 per cent were of contrary opinion. The cities outside of New England took, perhaps, a more progressive attitude for 76 per cent believed that beginnings should be made in the high school. If all our high school students were college preparatory, the discussion might come to an end and for some time to come let the colleges handle and dictate the problem. But a large part of our science students are not college preparatory. What of them? We are not believers in the segregation of knowledge, we are gregariously inclined and that is democratic, American like. We believe in letting the light of knowledge fall upon any willing recipient of that light. Hence electrons must be presented in our secondary schools so that the general student may have some idea of the modern conceptions of matter as well as his college inclined friends. This is the attitude as expressed by 75 per cent of the teachers. We are purposely educating the average student to enjoy a richer relationship of the problems of science to human welfare—to think, to read, to discuss these problems more intelligently, and to take his place in world affairs, though, perhaps as is believed, not so richly endowed with a broad vision as his college friends.

From the viewpoint of the high school student, would a knowledge of electrons benefit him later in his college science? There is no marked opinion among teachers about this though 60 per cent are of the impression that enough of the significance of electrons could be given in the short time that might be allotted to the work to benefit the student going to college—the remaining percentage being of a contrary mind. Really at best thought opinions on this point can only be considered a guess, since no returns are available to indicate otherwise. However, some educational psychology and common sense combined would explain away this difficulty.

Certainly no theory, those portions of the electron of which little is known and still hypothetical, should be given in Chemistry in secondary schools. That is for research. Overflow your course with theoretical statements which are oftentimes haphazardly given in elementary work and you are in a sure way to plant in the minds of your students, wrong conceptions which they take with them in later study. Early in the course the facts of Electron Theory can be used. Atoms are now divisible and

here should begin the explanation of the electrical composition of the elements, showing each element of the more common and the lower atomic number, with the possible arrangement of the electrons about the nucleus. With the new arrangement of the atom present, the instructor has now a more satisfying explanation for valence, ionization and the electro-chemical series, oxidation and reduction, temperature reactions in water solutions, the ionic reactions with acids, bases and salts, and the new periodic grouping of the elements according to their atomic number. The size of the nucleus and the distance of the valence electron determines what sort of atom it is—what element it belongs to and therefore its noticeable properties. Teachers are continually pointing out that the fundamentals of chemical reactions and valence are principles that have been hard for the pupil to visualize. They may find it easier to visualize these fundamentals by explaining some of the electronic concepts of the elements.

In conclusion, it is enough to say that the chemistry teacher has more than sufficient facts that have been established from the Theory for him to utilize throughout his course in Chemistry and withal, simple yet fundamental enough to keep away from theory. The wise teacher should not hesitate to present this New Theory of the Electron to his students. It is becoming the background for new thinking in the science of matter and to the alert student a new inspiration to know the Truth—and that is the guiding principle of all scientific endeavor.

REPORT ON QUESTIONNAIRE SENT TO CHEMISTRY TEACHERS CONCERNING THE ADVISABILITY OF INCLUDING THE ELECTRON THEORY IN HIGH SCHOOL CHEMISTRY

	Report from all the teachers from all schools		Report taken from expression of teachers in schools outside of New England States	
	Yes %	No %	Yes %	No %
1. Should any phase of the Electron Theory be taught in a first year high school chemistry course?	74	24	86	14
2. If so, should it be in the form of lectures to the students?	86	11	84	13
3. Should assignments on the Theory be given to students for home preparation?	27	69	50	49
4. Would it be advisable to introduce it when the Periodic Classification of elements is studied?	51	43	53	45
5. Should the Theory be introduced under the study of Atoms and Molecules?	65	30	60	38
6. Should recitations and examinations on the Theory be required of the student?	24	73	47	50
7.* How many hours (or periods) should be devoted to the subject during the school year?				

	Report from all the teachers from all schools		Report taken from expression of teachers in schools outside of New England States	
	Yes %	No %	Yes %	No %
8.* Which quarter of the school year would seem most advisable for the study of the Theory?				
9. Would it be advisable to present the subject to:				
a. College preparatory students?				
b. Students electing Chemistry from general courses?		Scattering reports		
c. Both classifications of students?	78	20	100	..
10. Could the Theory be best presented by assigning outside reading on the subject to students, followed by a report?	34	64	25	74
11. Should lectures and reports be correlated?	84	14	85	13
12. Is this a subject for only the colleges to treat?	47	51	24	74
13. Is it, in your opinion, wise for college instructors to demand of high school students a knowledge of the Theory?	14	82	36	62
14. Are you familiar enough with present college instruction to report whether or not a knowledge of this Theory is actually required of high school students?	6	91	15	75
15.* If so, in what colleges?				
16.* Are there any textbooks containing a presentation of this Theory in an elementary form?				
17.* What books treating on this subject would you recommend to high school students for reading?				
18. Do you believe that high school instructors feel competent to present this subject successfully?	26	71	40	55
19. Do you believe that the student could obtain enough of the Theory in the short time that would be allotted to the subject to benefit him later in his college Chemistry?	43	50	72	34
20. Are you teaching any part of the Theory to your chemistry classes?	73	25	90	8

* See report.

Correlation Problem

Be sure to send your criticisms on the enclosed outlines at your earliest convenience. The committee will deeply appreciate it.

THE VAPOR DENSITY OF STEAM*

W. L. EVANS, J. E. DAY, C. S. PEASE AND G. D. BLAND, OHIO STATE UNIVERSITY, COLUMBUS, OHIO

The classical experiments of Berzelius and Dumas by means of which these investigators showed that the elements hydrogen and oxygen unite to form water in the ratio of 1 : 7.98, respectively, do not furnish sufficient data to enable the beginner in chemistry to determine the exact formula for water. In addition to this quantitative data with reference to the composition of water, it is necessary that the vapor density of the compound be known in order that its molecular weight may be calculated. Obviously it is quite impractical for the beginner to actually weigh one liter of steam. However, we have found that this difficulty is overcome by transferring a known volume of steam into a small calcium chloride tube which has been previously weighed. The following are the details of the experiment.

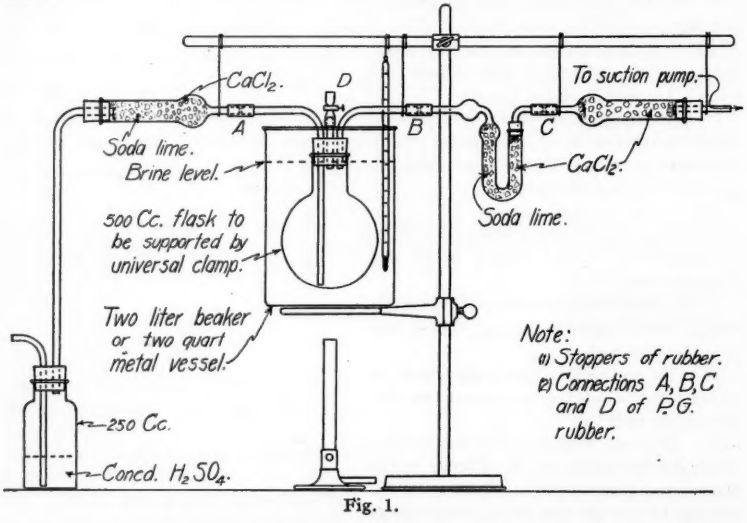

Fig. 1.

An apparatus is arranged in accordance with Fig. 1. Before the heating of the brine ($CaCl_2$) is begun, the U-tube is disconnected at B and C, and the soda lime-calcium chloride tube at A, the precaution being taken to close these tubes with the well known plugs made of glass rodding and rubber tubing. The U-tube is now weighed and then attached to the straight calcium chloride tube at C.

The screw clamp should be opened. When the temperature of the brine

* Read before the Division of Chemical Education of the American Chemical Society at the Milwaukee Meeting, Sept. 13, 1923.

is 106–110°, add 3 or 4 cc. of hot water to the flask. After the water has evaporated, this operation should be repeated at least twice in order to insure the complete removal of the air. Continue the heating until there is no water in the flask or tubes.

Immediately attach the straight drying tube at A and the U-tube at B and then close the screw clamp tightly. Start the suction pump and regulate it in such a manner that 2 to 3 bubbles of air per second pass through the sulfuric acid drying bottle. By this means dry carbon dioxide free air will be drawn through the apparatus and the steam will be swept into the U-tube. The temperature of the bath should be kept up during this operation.

When the steam has been completely carried into the U-tube (apply suction for about 40 minutes), disconnect this tube, insert the glass plug and reweigh. The gain in the weight of the U-tube is the weight of the known volume of steam. The following gram molecular weights of steam were calculated from experimental data obtained by some of our students: 19.02; 18.45; 15.9; 21.0; 18.02; 17.36; 17.96; 19.36; 18.0; 17.90. Knowing the percentage composition of water and its gram molecular weight the student could easily show that the formula of water is correctly represented by H_2O.

CHEMICAL ENGINEERING EDUCATION*

J. H. JAMES, CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA.

In the most cursory survey of the history of engineering, we can but note that this profession has had to become subdivided with the growth of our industrial life. The first engineer was the military officer engaged in the construction of all the walls, earthworks, etc., that went with warfare. The civil engineer was so named to distinguish his work from that of the military engineer—work largely similar, but having to do with the development of construction projects related to civil life. So it has gone on, as science developed and its application to industrial life increased we have seen successively the separation of new branches of engineering; in this way, mining engineering became established, then mechanical, electrical, metallurgical and finally the new comer—chemical engineering.

We have, even of late years, heard much criticism of the attempt of certain educators to establish courses in chemical engineering. Such statements as "the product of such a course is neither a chemist nor an engineer," and "an impossible hybrid" have been glibly uttered. The general argument of these critics is that we have here two great fields of activity, chemical science and mechanical engineering, and that a man

* Read before the Division of Chemical Education at the Washington meeting of the A. C. S., April 24, 1924.

should train himself for one or the other. If we were to admit some of this argument we would have to say that the particular set of mental faculties which would make a man a chemist are such that he cannot at the same time learn the elements of mechanical and electrical engineering. Or we would have to say that because of the time required for the necessary training, it is impossible to turn out an educated man for this new profession in four years or any other reasonable time of school attendance. The writer believes that the critics have their best argument right here, and will address himself to this phase of the problem later.

First, is the training ordinarily given in our courses in mechanical engineering the best for the activities of what has come to be called chemical engineering? As far as the work of the engineer relates only to the routine design and manufacture of standard mechanical equipment, perhaps we can grant that this part of our work can be handled best by the mechanical engineer. When it comes to the selection of proper materials for the equipment required for a new process we certainly cannot delegate this to our mechanical engineering friends. We may admit that many problems in construction are on the border line between the two professions, but even here there is developing very rapidly a large amount of apparatus, the design and construction of which is becoming exclusively the province of the chemical engineer.

The writer likes to think of the chemical engineer as a chemist as far as his knowledge of the chemical reactions of his manufacturing process goes, and as an engineer in connection with his operation of appliances, devices, machines, apparatus, etc., etc., necessary to large scale chemical operations. How much of the chemical engineer's training, then shall be chemistry, mathematics and physics, and how much shall be engineering, and particularly what shall be the character of the latter instruction?

Because of the peculiar needs of the industries based on chemistry, which have become more and more insistent during the past thirty years in this country and for a longer period in Europe, there is certainly justification for the attempts that have been made to give courses in chemical engineering, despite arguments to the contrary. In the United States, a younger country, with chemical engineering, one of the youngest of the professions, chemical engineering courses have not yet become at all standardized. Abundant proof of this statement is furnished in the summary of the replies to a questionnaire sent out a few years ago by the committee on chemical engineering education of the American Institute of Chemical Engineers (A. D. Little, *Chairman*).

The wide variation in the subjects included in the courses in chemical engineering (78 institutions in all were heard from), is, I believe, due to a number of causes, some of which can be traced to a difference in conception as to what is expected of the chemical engineer. A few of these causes

may be noted: in some cases, the courses were arranged by mechanical engineers; here engineering predominated with chemistry taking a subordinate place; in others, and these are more common, the courses were arranged by chemists, interested primarily in pure research, who, not having had the experience to get the industrial viewpoint, have made these courses top heavy on the chemical and scientific side.

There is still another reason for certain misfits that we know exist in many courses.

In connection with this point, the writer wishes to state his firm conviction that the outside engineering courses given to chemical engineers, should be arranged by the engineering departments concerned to cover *operation*, and not design. The engineering courses given chemical engineers should be *minor courses*, and not those that are given to students majoring in that particular department. All technical courses must be arranged to suit the *needs* of a given profession; what need is there for the chemical engineer to spend time on the details of motor design, for example? Is it not possible for the electrical engineering department of any technical school or university to teach the budding chemical engineer sufficient electrical science so that he may be able when "he gets out" to intelligently order motors for a given purpose, install them correctly, and finally to operate them?

Returning to the question of content of course, and the Little Report, we note that another fault with many of our institutions offering courses in chemical engineering, catalog a most varied assortment of subjects under this head. Perhaps we might include such subjects as Sanitary Biology and certain other phases of Sanitary Engineering, as well as certain divisions of Mining Engineering, but when such topics as Zoölogy and Irish Histroy are scheduled one is inclined to the belief that many institutions have rushed into this field before they were fitted to offer adequate courses. There is much evidence that in many cases the teachers arranging chemical engineering courses have had to cast about in order to fill in, using courses already given, with little reference to the real needs of the situation.

The wide variation in time given the same subject at different institutions is another matter that needs adjustment. This is a criticism that applies to other and older engineering courses as well. From the Little Report we can easily pick out such extremes as the following: the institution giving maximum lecture time to chemical subjects reports 1288 clock hours, while the minimum time reported was 240 clock hours. Taking Physics lectures, we find 297 clock hours reported as the maximum and 34 clock hours as the minimum, while the Mathematics maximum was 630 and minimum 160.

From a study of Mechanical Engineering courses made by Dean F. E. Ayer, of Akron University, with seventy-one institutions reporting, we

find figures just as surprising; Engineering subjects, maximum credit hours, 122, minimum, 47; Mathematics, maximum 33, minimum 12; Physics, maximum 24, minimum 6; English, maximum 18, minimum 4, and so on.

It is evident that some sort of standardization is needed in more than one branch of engineering education.

If we take all the numerous subjects listed in the chemical engineering courses of the country and group them under nine heads, we shall find that in spite of so much variation a great many educators are coming to about the same general conclusions as to content of course and time that should be allotted to each group. This suggestion was made by Dr. H. C. Parmelee, Chairman of the Educational Committee of the American Institute of Chemical Engineers.

Taking the nine groups as follows, a study can be made of chemical engineering courses with greater ease; Cultural Studies, Mathematics, Physics, Mechanics, Chemistry, Chemical Engineering, Other Engineering Courses, Other Sciences and Electives.

From an inspection of courses in chemical engineering in widely separated institutions, we can see that the men arranging the subjects have had, in most cases, the same general conception of the aim of the instruction as that outlined above. In the following table is given the classification noted for fourteen institutions giving four year courses in chemical engineering:

	Cultural studies %	Mathematics %	Physics %	Mechanics %	Chemistry %	Chem. Engr. %	Other engr. courses %	Other sciences %	Electives %	Remarks
A State Univ. in Far West	4.5	3.8	2.9	9.8	18.4	14.6	40.2	5.8	–	Chemistry and Cultural too low. Other Engr. too high
A State Univ. in Southwest	15.8	13.5	7.9	*	22	13.5	25.4	1.9	–	Chem rather low. Other engr. high
An Inst. in Middle West	11.9	8.3	5.4	7.3	23.3	22.8	18.8	–	2.2	Physics is certainly too low here
A State Univ. in Middle West	16.4	12	7.4	5.2	18.7	14.2	17.2	–	8.9	A fine distribution with perhaps cultural high
An Institute of Technology in New England	9.9	6.0	5.3	5.3	30.9	20.8	19.8	–	2.0	Cultural too low, apparently Physics is low, but this is made up under Chem. Engr.
A State Univ. in New England	16.5	10.8	8.6	3.6	41.1	6.4	13.0	–	–	Chem. too high and Chem. Engr. and Other Engr. too low

	Cultural studies %	Mathematics %	Physics %	Mechanics %	Chemisty %	Chem. engr. %	Other engr. courses %	Other sciences %	Electives %	Remarks
A State Univ. in the South	27.2	8.6	7.2	4.3	31.1	4.8	8.6	2.4	5.8	Cultural too high with Chem. Engr. and Other Engr. too low
A State Univ. in the Far South	3.8	14.2	8.8	2.5	32.6	2.5	19.2	–	16.4	Cultural too low and Chem. Engr. too low
An Eastern College	12.6	11.3	6.3	8.2	28.9	6.9	18.9	6.9	–	Chem. Engr. too low
An Eastern Univ.	11.4	6.1	5.7	–	68.3	2.4	4.4	–	1.7	This should not be called a course in Chem. Engr., and is too highly specialized for Chem.
A Southern School of Technology	11.4	12.7	10.2	4.8	34.2	7.2	17.5	1.2	0.7	Chemistry too high and Chem. Engr. too low
An Eastern Univ.	8.6	4.6	8.3	0.3	42.2	10.6	22.8	2.0	0.6	Math. and Mechanics too low with Chem. too high
An Institute of Technology in the Middle West	16.8	9.8	8.4	5.7	24.8	10.0	20.3	2.1	2.1	Cultural Studies too high and Chem. Engr. too low
An Eastern Polytechnic Inst.	10.2	6.7	6.6	6.8	35.5	11.6	20.0	0.6	2.0	Cultural might be increased and Chemistry decreased

* Mechanics included under heads.

The foregoing comments are based on the idea that in the four year course we must arrange for the best utilization of the time on strictly essential subjects together with some cultural work. The writer would like to suggest the following approximation for the nine groups of subjects:

A.	Cultural Studies	between 10% and 12%
B.	Mathematics	between 9% and 12%
C.	Physics	between 7% and 10%
D.	Mechanics	between 4% and 7%
E.	Chemistry	between 25% and 30%
F.	Chemical Engineering	between 10% and 15%
G.	Other Engineering Courses	between 15% and 20%
H.	Other Sciences	between 3% and 6%
I.	Electives	between 1% and 3%

Finally, it should be noted that economic pressure has rather forced on American institutions the four year engineering course, making necessary just such considerations as we have been making as to content of course. The average student in our engineering schools is there primarily because he wishes to improve his condition in life. Too few of our students in engineering are fired with a love for the basic sciences underlying their particular engineering field. The average engineering graduate steps into routine production. Of course such men are needed by modern industry; all cannot be leaders, but we cannot get away from the idea that it is unfortunate for the engineering profession that economic pressure has made the four year course the standard in most of our institutions. Engineering education is not today on the same high plane as that of the professional courses in Law and Medicine. The ideal plan would be: a four year liberal arts college course, followed by two or three years of high grade professional training involving much research work. American educators are on the wrong track in taking boys out of high school and crowding them through a four year engineering course. The technical graduates are succeeding—yes, but how much better would be their success, and how much higher the engineering profession would be, if the training were done more deliberately, if the graduates were turned out at a period of greater maturity and if sufficient research work were introduced in their training to fire the creative spirit in the few, who in the final analysis make the real advances in all lines of engineering.

PROGRESS OF COMMITTEE ON CHEMICAL EDUCATION OF THE A. C. S.—II

Since the Washington Meeting of the Society, the Committee of Chemical Education of the A. C. S. has been trying to improve and complete the three projects mentioned in its first report,[1] that is, it has been striving,

1. To increase the value of the JOURNAL OF CHEMICAL EDUCATION to its readers
2. To inaugurate more definite plans for encouraging the formation of Associations of chemistry teachers
3. To complete the project of the Correlation of High School and College Chemistry.

The status of each of these lines of work will be stated briefly.

Journal of Chemical Education

A few of the many comments received from the first six issues of the JOURNAL will show that the Committee's efforts, to make it valuable to its readers, are bearing fruit:

[1] *J. Chem. Educ.*, **1**, 33 (1924).

"I am pleased beyond power of words to express, that the Journal of Chemical Education is a realized fact. I will support it to the last ditch and will coöperate in any way possible to make it a success."

"Accept the congratulations (and two dollars) of a confirmed skeptic of anything that has the term 'Education' attached to it: but the new Journal, if you can keep up to the first copies, is just what is needed. It will be a real help, especially to us in small schools, more or less out of touch with things. The article on 'What We Teach our Freshmen' alone is worth the price of admission."

"After rather anxious and curious waiting the first issue of the Journal of Chemical Education has been received and thoroughly enjoyed. I had hopes that it would be worth while and they have been realized in the first numbers."

"The Journal of Chemical Education has been received with enthusiasm by education members of this section of the society."

"After looking over a recent issue of the Journal of Chemical Education, I was so favorably impressed with it that I am enclosing my check for one year's subscription. I should like, if possible to have the subscription begin with the issue of January 1924."

Arrangements are being made to send the September issue to every member of the A. C. S., and to the 15,000 or more chemistry teachers who are not members of the Society. The total circulation will be approximately 30,000. There is no reason why THIS JOURNAL should not have a paid circulation of 20,000. It should be worth $2.00 to every man or woman to whom this issue is sent. If it is not, let us know how it can be improved so that it may have such value. Suggestions are earnestly requested. A blank on the outside cover page has been left for your convenience in sending in your subscription.

State Associations of Chemistry Teachers

Since the Spring Meeting of the Society, four states, Washington. Montana, Oregon and Idaho, have formed themselves into a regional association of chemistry teachers under the encouragement of Thomas G, Thompson. The present status of this association may be gleaned from page 168 of THIS JOURNAL. This makes twelve states in the Union which are definitely organized from the standpoint of chemistry teachers. The States in addition to those named above are, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York (City) and Maryland.

Reports from other states give the Committee reason to believe that many other associations will be formed during the coming year. The committee is making arrangements whereby a representative of the American Chemical Society will give a portion of his time during the coming school and college year, helping with this fundamental problem, provided such help is desired.

These associations permit the teachers, (1) to get together to talk over their common problems, (2) to take an active interest in matters taken up in the Division of Chemical Education of the A. C. S., (3) to aid the Committee of Chemical Education in carrying out such national projects as the Correlation of High School and College Chemistry, (4) to take a more active part in the National Chemical Prize Essay Contest, and (5) they may be given such power as nominating the editors to THIS JOURNAL. Such Associations can have nothing to lose but everything to gain.

Correlation of High School and College Chemistry

30,000 reprints of the Committee's preliminary report on the Correlation problem have been issued. A copy is enclosed for your criticism. The Committee is desirous of completing its recommendations to the Council not later than the Spring Meeting of the Society. This will only be made possible if each man and woman receiving this issue will criticise the outlines on the points given below, and return at once to the Office of the Chairman, University of Maryland, College Park, Md.

1. What topics would you omit from the standard high school outline?
2. What topics would you add?
3. What topics would you omit from the college outline?
4. What topics would you add?
5. What topics would you change from the high school outline to the college outline, or vice versa?

The Committee is trying to put these outlines in harmony with what a majority of the chemists desire. If you do not send any criticism, the Committee has no other way except to consider that you approve the outlines as they now stand. We feel sure that you have some fine suggestions. Let us hear from you.

The Committee wishes to take this opportunity to thank the men and women who have taken an active part in the promotion of the three above projects.

The interest being shown in chemical education is most encouraging. There seems to be an awakening to the fact that the quality and quantity of our chemist and the membership of the American Chemical Society during the next generation largely depends on the chemical education of today.

Respectfully submitted,

NEIL E. GORDON, *Chairman*
B. S. HOPKINS
J. R. KUEBLER
L. W. MATTERN
L. C. NEWELL
R. E. ROSE
WALTER SCHMIDT
W. SEGERBLOM
R. E. SWAIN
T. G. THOMPSON
F. W. WILLARD

Requests

What teaching problems are giving you the greatest trouble? We are anxious to publish articles which will have the greatest value to the chemistry teacher. Let us hear from you.

SOMETHING DONE AND AN OPPORTUNITY

Over twenty thousand teachers and an equal number of other business and professional men and women have coöperated to make the American Chemical Society's Prize Essay Contest a success. The enthusiasm and hard work expended warrants the assumption that the spirit in which the enterprise was undertaken, its necessity, and the underlying value of it was appreciated. Probably nothing could more emphatically express the humanitarian principles behind the project, than two letters written by the Honorable Francis P. Garvan, President of the Chemical Foundation, Inc., addressed to the Council of the American Chemical Society. At the Spring meeting of the Society, held at New Haven, Conn., in June 1923, Mr. and Mrs. Garvan offered to provide funds to conduct a Prize Essay Contest as a memorial to their daughter Patricia. In his letter to the Council Mr. Garvan said:

"In order that the youth of our country may have an intelligent appreciation of the vital relation of the development of chemistry to our national defense, to the intensification and purification of industry and agriculture and to the progress of medicine through the 'Age of Chemistry' upon which we have entered, and in memory of our daughter, Patricia, Mrs. Garvan and myself tender to you the sum of ten thousand dollars. Six thousand dollars is to be expended by you in awarding in each State six prizes of twenty dollars in gold to the students in all secondary schools, public and private, for the six best essays evidencing an understanding of the importance of chemistry in our national life. The remaining four thousand dollars is to defray the expenses of the contest.

"In addition, we have provided for six four-year scholarships in chemistry, or chemical engineering at Yale University or Vassar College, to be awarded by you among the successful contestants in each of the several States. These scholarships will carry five hundred dollars a year and tuition. The choice of subjects, all rules and regulations governing the contest, the awarding of the prizes, and scholarships, etc., are to be under your absolute control and direction."

The proposal was accepted by the Society, and on August 21, 1923, President E. C. Franklin, appointed a committee of four: H. E. Howe, Editor of "Industrial and Engineering Chemistry," *Chairman;* Wilder D. Bancroft, of Cornell University; Charles H. Herty, President of the Synthetic Organic Chemical Manufacturers' Association; and Alexander Williams, Jr., of the Chemical Foundation, Inc., *Secretary,* to take charge of the contest.

The second letter of Mr. Garvan dated April 18, 1924, was read to the Council of the American Chemical Society at their spring meeting in Washington, D. C., in June, 1924. In this letter Mr. Garvan says:

"Returns from the prize essay contest conducted under the direction of

the American Chemical Society during the year past indicate that the contest's objectives which were to arouse 'an intelligent appreciation of the vital relation of the development of chemistry to our national defense, to the intensification and purification of industry and agriculture and to the progress of medicine through the "Age of Chemistry" upon which we have entered' were attained. The contest also awakened great interest in chemistry and the allied sciences in the High schools and among the people of this country generally. Upon the foundation laid by your organization during the past year we feel that still greater results may be obtained in inducing students to take more interest in scientific studies.

"Mrs. Garvan and myself, therefore, again desire to tender to you for the continuance of the contest a sum sufficient to duplicate the present awards. Furthermore we desire to add six one thousand dollar prizes for the best essays on the group of selected subjects written by students of universities and colleges in the United States.

"We take this opportunity to express our appreciation of the coöperation of all the members of the Society in furthering this project during the past year. We are entirely satisfied with the results obtained and have been pleased and touched by the interest shown by boys and girls all over the country."

During the period of a year which had elapsed from the acceptance of Mr. and Mrs. Garvan's proposal by the Council of the American Chemical Society to the receipt of Mr. Garvan's second letter, an enterprise national in scope had been planned, an organization to carry out the work had been completed, and the whole was operating successfully. Details are always uninteresting, but it seems proper that some of these should be given to illustrate the true nature of the project and its ramifications.

One of the first activities undertaken by the committee appointed by President Franklin was the formation of a national committee of judges to whom would be entrusted the task of awarding the six four-year scholarships. It was felt that the National Committee should be representative of all of the interests of the country. The purpose of the Prize Essay Contest was not to induce boys and girls to enter the profession of chemistry, but to instill in them a real interest in the subject, and an appreciation of its importance in every day life. Therefore the National Committee when completed represented not only the chemical profession and educational activities of the country, but all lines of endeavor.

The Honorable Herbert Hoover, Secretary of Commerce of the United States, accepted the chairmanship of the National Committee, which also included, J. R. Angell, President of Yale University; Charles H. Mayo, Surgeon, Mayo Foundation; James W. Wadsworth, Jr., Senator (New York), Chairman U. S. Senate Committee on Military Affairs; Jane Addams, Settlement Worker; J. C. Merriam, Carnegie Institution;

Robert J. Cuddihy, Literary Digest; George Eastman, Eastman Kodak Co.; Julius Rosenwald, Sears Roebuck & Co.; H. N. MacCracken, President of Vassar College; Edgar F. Smith, ex-Provost of University of Pennsylvania and Past President of American Chemical Society; Arthur Capper, Senator (Kansas), U. S. Senate Committee on Agriculture and Forestry; Ida Tarbell, Editor; Alice Ames Winter (Mrs.), General Federation of Women's Clubs; Robert Andrews Millikan, Physicist; Frederick E. Weyerhaeuser; Lumberman; and J. J. Carty, Vice-President American Telephone & Telegraph Company.

Similar committees were appointed in each of the several states, and an effort was made in every instance to secure persons for these committees who were widely identified with the life of their communities. The cooperation of the United States Bureau of Education, and the various state departments of education and organizations such as the American Medical Association, and the American Library Association were also secured.

Another important question which confronted the committee at the outset, was the selection of suitable subjects upon which high and secondary school students should be requested to write, and finally the six subjects selected were:

The Relation of Chemistry to Health and Disease.
The Relation of Chemistry to the Enrichment of Life.
The Relation of Chemistry to Agriculture and Forestry.
The Relation of Chemistry to National Defense.
The Relation of Chemistry to the Home.
The Relation of Chemistry to the Development of the Industries and Resources of your State.

Early in the contest it was found that students of high school grade who had not taken up the study of chemistry were handicapped, owing to the general lack and availability of authoritative and accurate non-technical books on the subject. A bibliography was prepared, and it was determined that of the non-technical literature on the subject, five books were preeminent, and covered the subject most thoroughly. These are:

Creative Chemistry, by Edwin E. Slosson.
Life of Pasteur, by R. Vallery-Radot.
The Riddle of the Rhine, by Victor Lefebure.
Discovery, The Spirit and Service of Science, by Sir Richard Gregory.
The Future Independence and Progress of American Medicine in the Age of Chemistry, by a Committee of the American Chemical Society.

Then another difficulty arose, as it was found that even though books were recommended for reading, they were not available to the great majority of students. Publishers were called into consultation, and through the good offices of the Chemical Foundation, the committee was able to secure a great number of sets of these five books.

Every accredited high school and secondary school and all of the leading libraries of the country were donated sets of these books, and the expenditures in connection with the printing, publication and distribution of this literature were borne by the Chemical Foundation. Books were placed in the hands of educational officials all over the country, all the members of the National and State Committees were presented with them, and interested individuals were enabled to purchase them at the cost price of $2.50 for the entire set post-paid. During the year over 20,000 sets of books were distributed free of charge.

The result of this work was immediately apparent. Through students the books were taken into homes throughout the country, their widespread distribution reached and impressed business and professional men and women who hitherto had given little thought to the importance of science and of chemistry in particular in their daily round, and from its original status of a student competition the Prize Essay Contest became a national project with the widest possible background.

The results of the contest itself were of greater value than the fondest estimate of its founders had anticipated. The questionnaire sent to all of the accredited high and secondary schools in the country shows that upwards of 500,000 boys and girls actively engaged in the preparation of papers for the competition, and that books distributed through the Committee and the Chemical Foundation reached probably three times that many students and others who became interested. Teachers and educational officials from all sections report a newly awakened interest in chemistry and the allied sciences and in several cases schools which had hitherto not conducted chemistry courses, were induced through the pressure of students to establish classes.

Libraries report a much increased demand for books on scientific subjects, colleges and universities inform the committee that their work has been facilitated greatly by the contest, and in several instances colleges state that their enrollment of freshmen students in chemistry courses had increased from ten to twenty-five per cent. The interest taken by the higher educational institutions has been demonstrated by the fact that eighteen scholarships were set aside by universities to be awarded to the students of the several states who won prizes in the contest. In addition to this, it was found that the Prize Essay Contest afforded a medium through which the faculties of the universities were enabled to get into active touch with the students of secondary schools, and the good resulting from this closer relationship has been incalculable.

Several universities seized the opportunity of using the Prize Essay Contest in conjunction with their already established extension work. Particularly in the western and southern states, the universities found it advisable to use sets of the five reference books supplied by the Committee

as circulating libraries and this procedure was followed by several of the State libraries and library associations.

The contest was ably supported by the newspapers throughout the country and the Committee on Prize Essays aided by state committees and various members of the National Committee sent out numerous news releases throughout the year which resulted in wide publicity, and was supplemented by posters and other literature. Teachers' associations and various other educational and scientific bodies showed their approval of the contest by formally drafted resolutions and in many instances this moral support was backed by the active aid of the associations in question.

At first it was planned to have the papers entered in the contest submitted directly to the State committees, and they were to select from the mass of entries the six best on each subject. When the papers began to arrive, however, it was soon apparent that this was a task beyond the powers of the committees alone, and a call for volunteers was sent to all of the local sections of the American Chemical Society and to chemistry teachers generally. Nothing so well demonstrates the spirit of coöperation which was so conspicuous throughout the year than the manner in which the members of the Society and of the scientific fraternity in general responded to this call. Auxiliary state committees were quickly formed and to them fell the more or less thankless task of weeding out the best from among the essays submitted. In this way, only those worthy of attention were brought before the committee of judges and these committees were aided in their work by the knowledge that the essays had been examined for accuracy of statement and of fact before they came to them.

The six best essays in each of the states were forwarded to the Committee on Prize Essays and were placed in the hands of a special committee composed of members of the Division of Chemical Education of the American Chemical Society. This committee eliminated all but the eighteen which were considered best and these eighteen were turned over to the National Committee who selected as winners in the national contest, Donald L. Vivian, 3323 North Central Avenue, Phoenix, Arizona, of the Phoenix Union High School for his essay on "The Relation of Chemistry to Health and Disease:" James Cole Reid, Dallas, Texas, of the Bryan Street High School, for his essay on "The Relation of Chemistry to the Enrichment of Life;" Oliver Chandler Pittman, 30 Homer Street, Commerce, Georgia, of the Commerce High School, for his essay on "The Relation of Chemistry to Agriculture and Forestry;" Elton R. Allison, 402 North Buckner Street, Centralia, Washington, of the Centralia High School, for his essay on "The Relation of Chemistry to National Defense;" Benjamin Nassau, 130 Nelson Street, Hartford, Connecticut, of the Hartford Public High School, for his essay on "The Relation of Chemistry to the Home" and Eugene Russell Brownscombe, 839 Third

Street, Santa Rosa, California, of the Santa Rosa High School, for his essay on "The Relation of Chemistry to the Development of the Industries and Resources of California."

A most interesting fact in connection with the work was that the six winners in the national contest are all boys who need assistance if they are to obtain a college education. It is unnecessary to cause embarrassment by reciting the circumstances in each case, but one is an orphan, two contribute to the support of a widowed mother and the rest are of parents whose means are limited in the extreme. Another interesting thing is that, of the six, only two are sufficiently advanced scholars to enter Yale this year.

It may be said then that the Prize Essay Contest in 1923–24 was a success. All of its objectives were attained and many of the results were greater than had been expected. As in all other lines of human endeavor, however, the goal when reached, proves to be not an end, but a beginning.

A greater and wider field opens before the contest of the future. It is more than a mere educational propagandistic enterprise. It presents an opportunity of unifying once and for all the forces in operation today which make our modern educational system what it is.

There can be no doubt that the world is entering upon a great renaissance of science. Scientific progress in the last two or three decades has been tremendous and everything points to even more vigorous and extensive progress within the next few years. There can be then, no greater or better work than the bringing home of this truth to the student of today. Even though the boys and girls in school may not elect to follow a scientific career it is extremely necessary that they be alive to the progress that is being made. That the Prize Essay Contest accomplishes this end has been shown by the experiences of the past year, but if a great and lasting good is to be achieved, a proportionately greater effort must be expended.

Much is being done by a committee which is now investigating conditions in secondary schools and in colleges and which will make recommendations as to the proper method of obtaining the adequate coöperation and correlation of high school and college chemistry. Still more may be done along these lines if the science teachers of this country can be banded together in a cohesive, correlative association or group of associations.

For this purpose the Prize Essay Contest offers a peculiarly well fitted vehicle. Its interest is nation wide. Its work touches every class and condition of men and women. With the prizes for college students that have been added to the contest of 1924–25, its scope has been widened and every science instructor and every student taking scientific courses in the schools and colleges of this country has a personal interest in it.

Where there are organized associations of teachers, the contest may be used by members as a means of enlisting an interest other than a purely

academic one among students. Where no organizations exist the contest offers sufficient scope to warrant the establishment of such organizations. The Educational Division of the American Chemical Society stands ready to welcome any such activity and with the American Chemical Society as a connecting link there is no limit to the power that may be exerted by chemistry teachers' organizations held together by a nation-wide movement.

In a recent speech at a dinner given in his honor by the six great chemical organizations of the United States, Mr. Garvan took as his text "and a little child shall lead them." There can be no nobler text nor a more worthy sentiment expressed, and certainly the prize essay contest with this as its motto and with the coöperation of teachers and scientists may accomplish one of the greatest works of our time.

H. E. HOWE, *Chairman* CHARLES H. HERTY
WILDER D. BANCROFT ALEXANDER WILLIAMS, JR., *Secretary*

CHEMISTRY IN GRADES[1]

Miss M. Elizabeth Farson, Principal of the Hamilton School, Chicago, Ill., has been trying an experiment training her pupils in latent imaginative thought by comparison and symbolism through the use of chemistry and kindred sciences. The periodic table was used as one experiment in this mind stimulation. After she had told her pupils in her vivid way about the periodic table and allied terms, she gave a test asking each child to give a sentence which would characterize the different terms. A few quotations are given in order that other teachers may judge for themselves as to the value of the experiment.

1. Ancient Chemistry—Leon Green
   Ships far off at sea
   Seeking the Periodic City
2. Elements—Arthur Schroder
   Ninety-two nails
   Holding the Periodic Table together
3. Hydrogen—Edith Carlson
   Homeless Wander
   Nobody wants him on his street
4. Group Eight—Theresa Lehmann
   Three sets of triplets
   All living on the same broad avenue
5. Argon—Dorothy Dunne
   Oh! Such a Sleepy Rip Van Winkle
   Too lazy to wake up
6. X-Rays—William Boick
   Miners searching in a crystal mine
   For buried treasure
7. Millikan—Barbara Diezel
   An Abraham Lincoln
   Trying to free the Electron
8. Bohr's Atomic Orbits—Raymond Taylor
   Electrons' Racetracks
   Judge Proton in grand stand in center
9. Chemistry—Violet Nieman
   Mysterious wonderland
   Bewildering many an Alice

For more quotations and particulars about the experiment write Miss Farson.

[1] EDITOR'S NOTE.—This is published due to the many calls from teachers for literature on humanizing chemistry. The editor would like to have some contributions from a chemical drama standpoint.

Local Activities and Opportunities

Northwest Chemistry Teachers Association: On July 15th about thirty teachers of chemistry in the Northwest representing the states of Washington, Oregon, Idaho and Montana, met at the University of Washington and took initial steps towards organization. The feeling is very general that such an organization would be of great benefit and during the year, efforts will be made to get in contact with all the teachers of chemistry in these states. Mr. Clarence Wassberg of Queen Anne High School, Seattle, Washington, was elected temporary president and Mr. Philippi, head of the department of chemistry of Bellingham Normal School, was elected temporary secretary. A committee was appointed to draw up constitution and by-laws.

It was suggested at the meeting that dues of about $2.50 be charged each member. Out of this amount, 50c should be kept for the organization for running expenses and the $2.00 go towards the subscription to the Journal of Chemical Education.

The meeting was preceded by a dinner and the program afterwards was as follows: "The Aims of the Average High School Teacher in Chemistry," by Mr. H. F. Cope of the Medford, Oregon High School; "The Preparation of High School Teachers of Chemistry," by Mr. O. A. Baarson of Burley, Idaho High School; "Coördination of High School and College Chemistry," by Mr. C. S. Van Vleet, Vancouver, Washington, High School; "Application of Psychology to Chemistry," by Mr. Philippi of Bellingham Normal School, Washington; "The Prize Essay Contest as an Aid to High School Teachers," by Dr. W. Semon, University of Washington; "Coöperation of the Department of Chemistry with the High School Teachers," by Dr. H. K. Benson, head of the Department of Chemistry, University of Washington.

News from Wisconsin. In memory of their son, Carl G. Kremers, Professor and Mrs. Edward Kremers have given the sum of $1000 to the University. Professor Kremers is Director of the Pharmacy Course and of the Wisconsin Pharmaceutical Experiment Station. The money will be added to other funds, the income of which is to be used by the Station for carrying on studies in Chemotherapy.

The honorary degree of Doctor of Science has been conferred upon Dr. O. P. Watts, Associate Professor of Chemical Engineering by his Alma Mater, Bowdoin College. The degree was conferred in recognition of his investigations in the field of Electrochemistry.

Drs. Homer B. Adkins and Farrington Daniels have been advanced from assistant to associate professorships.

Dr. Glenn S. Skinner has resigned his position as Assistant Professor of Chemistry. He has not announced his plans for the future.

Dr. Joel B. Peterson and Stanley L. Chisholm have given up their instructorships in Chemistry to enter the commercial field. Dr. Peterson has joined the laboratory staff of the American Medical Association at Chicago.

Nineteen Doctor of Philosophy degrees in Chemistry were conferred at the 71st annual Commencement of the University of Wisconsin. Thirty-one graduate students in chemistry received the degree of Master of Science. Four of this number were women.

Noted New Professors at Hopkins: Dr. F. O. Rice has been appointed in the field of physical organic chemistry. Dr. Rice received the B.Sc. from the University of Liverpool in 1907, the M.Sc. in 1912 and D.Sc. in 1916 from the same university. In 1914 he was awarded the 1851 Exhibition travelling fellowship to continue work at the University of Berlin. He has been spending most of his time during the vacation abroad on research work in the laboratory of Professor Bodenstein.

The second appointment is that of Dr. F. Russell Bichowsky in thermodynamics. Dr. Bichowsky received his A.B. from Pomona College in 1912 and M.S. and Ph.D. from the University of California in 1914 and 1916, respectively. From 1916–19 he was assistant chemist at the Geophysical Laboratory, Washington. From 1919–1923 he was National Research Fellow and Research Associate at the University of California. At the present time he is assistant editor in charge of the thermochemical data for the International Critical Tables. This work will either be completed before fall or after his arrival in Baltimore. Dr. Bichowsky also has to his credit a number of articles on his researches and has given most of his time to the subject of thermodynamics and its applications to chemistry.

A third appointment, in the field of photochemistry, is yet to be made. The chemical department is giving careful consideration to the appointment of the man for this important place and is not yet prepared to make any announcement.

It is expected that all of these men will give short courses of lectures to the graduate students in their respective fields but will give most of their time and effort to their own researches and to the guidance of graduate students in problems

in which they are interested. By means of these appointments the Department of Chemistry of the Johns Hopkins University expects to double its output of research work.

Teaching Position: Wanted position as instructor in chemistry in a university or as assistant professor in college. Two years teaching experience and two years commercial work. A candidate for an M.S. in chemistry. Adequate references. Address J. CHEM. EDUC., Easton, Pa.

Assistant in Chemistry: The Department of Agricultural Chemistry at the University of New Hampshire needs an Assistant in Chemistry. Will be given an opportunity to do some graduate work. For particulars write H. R. Kraybill, Head of the Department of Agriculture Chemistry.

Honors: Miss Mildred Grafflin who received her M.S. degree in chemistry at the University of Maryland last June, won the Van Meter $1000 fellowship which entitles her to carry on her graduate work at Yale University during 1924–25. The fellowship is given by Goucher College where Miss Grafflin took her undergraduate work.

Dr. M. Kharasch who has been in Chicago during the summer doing work in connection with the International Critical Tables expects to return to the University of Maryland on Sept. 15 when he will resume his duties as Head of the Division of Organic Chemistry.

Recent Books

Eminent American Chemists, by D. H. KILLEFFER, Associate Editor, Industrial & Engineering Chemistry. Published by D. H. Killeffer, 19 East 24th Street, New York City, 1924. 33 Portraits. Price $6.00.

It seems to the reviewer that Mr. Killeffer has started a present day need among Chemistry teachers. The history of the Americans who have helped to make our chemical science is a recognized phase of Chemical Education.

The thirty-three portraits selected for inclusion in this book are portrayed in a most modern manner 4½ by 6 inches in size with sufficient margin for framing (on 8 × 10 inch sheets). Each portrait is on a separate sheet. The alternate sheets contain brief sketches of the works of each man. The whole is bound in such a manner as to give an attractive form for the library, and at the same time in a manner which permits the removal of any or all of the portraits. I understand from the author that only the complete portfolios are available, that a separate selection of prints cannot be made.

The following is a list of those whose portraits are included:

Backeland, L. H.	Gomberg, Moses
Baltwood, B. B.	Hare, Robert
Bancroft, W. D.	Hillebrand, W. F.
Booth, J. C.	Hunt, T. Sterry
Chandler, C. F.	Langmuir, Irving
Chittenden, R. H.	Lewis, G. N.
Clarke, F. W.	Mallett, J. W.
Cottrell, F. G.	Morley, E. W.
Cooke, Josiah P.	Noyes, A. A.
Franklin, E. C.	Noyes, W. A.
Gibbs, J. Willard	Priestley, Joseph
Gibbs, Wolcott	Remsen, Ira
Richards, T. W.	Smith, J. Lawrence
Rumford, Count	Stieglitz, Julius
Silliman, Benjamin, Sr.	Van Slyke, Donald D.
Smith, Edgar F.	Whitney, W. R.
	Wiley, H. W.

It is interesting to note the sources from which some of the portraits have been copied. That of Priestley, is a reproduction of the Stuart portrait which now hangs in the National Museum in Washington, the gift of the American Chemical Society to the Museum. Those of J. Lawrence Smith and T. Sterry Hunt have been enlarged from the group of American chemists who gathered at the grave of Priestley at Northumberland, Pennsylvania, on the centenary of the discovery of oxygen in 1876. The portraits of Booth, Hare, Rumford and Silliman are reproductions of contemporary prints. All the others are reproduced from photographs.

Chemistry teachers may be at first disappointed to find certain men omitted whom they feel should be numbered with the great, but the author acknowledges the seriousness of this selective problem, and believes that he has made only a start in the right direction.

NEIL E. GORDON.

College Chemistry Companion, by JAMES KENDALL. The Century Co., New York, 1924. xiii + 233 pages. 13 × 20 cm.

This is something new in the way of texts for the beginner in Chemistry. In fact it is not a text at all, but rather a series of informal explanations of the more formal text, such as would be obtained, ordinarily, only through personal consultation—a sort of teacher ever at the student's command. Its sole purpose is to teach

the student how to study what he is apt to consider a difficult subject. Although "For use in conjunction with the revised editions of Smith's 'College Chemistry' and 'A Laboratory Outline of College Chemistry,' it could quite as well be used with almost any of the standard texts."

Professor Kendall has accomplished his purpose by picking out the high spots in each chapter of the text mentioned, analyzing and explaining them in a fashion impossible to the formal text and nearly so to the average lecture. Bad misapplications of certain chemical truths are carefully pointed out so that the neophyte may not be lead astray by his enthusiasm. A science capable of being expressed in mathematical terms can be properly taught only through the extensive use of problems. This book abounds in such problems. There is a large number of well selected types at the end of each chapter, and the student is repeatedly urged to try as many as possible. A careful reading of the chapter will have given him all the assistance necessary. It must be emphasized, however, that this is not fundamentally a "problem" book.

To anyone reading Prof. Kendall's book for the first time, the rather radical departure from the dignified language of the average text is startling. The author justifies this by saying, "The human touch is almost indispensable in undergraduate chemistry, and the teacher who scorns to stoop cannot complain if he fails to conquer." With this we agree heartily. However, it seems, in a few instances, as if the author had allowed his sense of humor to carry him beyond the necessity of making the subject human.

Introductory Chapter II is most excellent. It is entitled "Hints on Lecture and Laboratory Work." We are convinced that far more students become discouraged from simply not knowing *how* to study than for any other reason.

Professor Kendall is very wise in teaching students early in their chemical life that multiplicity of decimals does not necessarily indicate accuracy of work. His discussion of errors is very good.

At the end of all the later chapters have been placed well selected literature references to present day work along the lines discussed in those chapters. Other features included in this book that help to make it human and chemistry an interesting subject are extensive quotations from contemporary speeches and writings, illustrations (both historical and contemporary), and lists of eminent chemists of our time with some of their achievements.

In conclusion, this is a very good book for students, and is packed full of ideas for teachers.

MALCOLM M. HARING.

Applied Chemistry, by IRA D. GARARD, PH.D., Professor of Chemistry in the New Jersey College for Women, State University of New Jersey. The Macmillan Company, New York, 1924.

To quote from the preface, "The purpose of this book is mainly to provide a textbook for college students who have taken a course in general chemistry and who are further interested in the applications of chemistry and the manner in which it functions in modern life." The purpose of the work is admirable; it attempts to fill a wide gap in our available works on chemistry, but the reviewer doubts if it could be understood and appreciated by those for whom it is intended.

The tendency throughout the book is to use terms and refer to complex compounds, which would be new to the sophomore reader, before giving an explanation. The subject matter covers so wide a field, and introduces so many complex conceptions that the reviewer fears that the second-year reader would require many extra explanations.

As a book of suggestions to teachers, Dr. Garard's book should prove invaluable. The information given appears to be quite correct, and could readily be modified, or simplified to be given to the students in lecture form.

JOHN H. GARDNER.

What Industry Owes to Chemical Science, by RICHARD B. PITCHER, O.B.E., and FRANK BUTLER-JONES, B.A. (Cantab), A.I.C. With an introduction by Sir George Beilby, LL.D., F.R.S. Second edition, revised and enlarged, D. Van Nostrand Company, New York, 1924. xv + 158 pages. Price $2.00.

This book is a partly successful attempt to describe, in a manner understandable to the general reader, the indebtedness of all industries to pure scientific research, and particularly to chemistry. It contains the greatest mass of information compressed into a small space that the reviewer has ever seen, but, unfortunately, much of it is misleading, although there are few positive mistakes.

In many places, obsolete, or obsolescent, processes are emphasized more than their more modern successors. The reader would be left with the impression that the Weldon and Deacon processes for chlorine are more generally used than the electrolytic.

The book is better suited to British than to American readers as it stresses the development of the British industries and the work of British scientists, although it is not noticeably unfair to those of other nations.

As a book for supplementary reading for chemistry students, this work might well find a place, particularly if the instructor were to accompany his recommendation with an explanation of its nature.

JOHN H. GARDNER.